

Space Weather Technical Forecast

Issued on Tuesday, 24 September 2024 at 01:10 Local

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: G1/Minor Geomagnetic Storm likely, mainly Day 2 (25 Sep) due to coronal hole high speed stream and a possible glancing blow CME. Chance of M-flares (R1-R2 Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate with a flare peaking at M1.3, at 23/1457 UTC from AR3836 with a contribution from AR3833. There are currently nine sunspot regions on the visible disc, with a new region developing north of AR3835. AR3833 in the northwest has been fading, but still just about contains a delta spot. AR3828 is also of note, but any opposite polarity spots have now faded. The new region on the southeast limb has been numbered AR3836 and remains very difficult to assess due to foreshortening near the limb, but is showing some notable looping in SDO imagery, so is one to watch. Remaining regions appear mostly small or simple at the present time.

A CME was observed 22-23 Sep, directed primarily to the south and east, mostly away from Earth. However, analysis suggests a possible glancing blow on Day 2 (25 Sep), likely from the shock associated with the CME. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE at L1, showed an increase to slightly elevated levels, likely due to a weak CME arrival around 23/1140 UTC. Wind speeds were initially near 350 km/s, increasing to vary between 380-460 km/s after the CME arrival. Density was below average, briefly reaching above average after the CME arrival, before declining once again. Interplanetary Magnetic Field, Bt, was mostly weak at first, becoming moderate after the CME arrival with peaks of 12 nT. The north-south component, Bz, was initially weakly variable, becoming moderately southward directed after the CME arrival, then rotating to become northward directed around 23/1535 UTC. Phi angle has been predominately negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2), becoming Unsettled to Active (Kp 3-4) between 23/0900-1800 UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was mainly moderate, briefly touching high, with a peak of 1390 pfu at 23/1445 UTC. The associated 24-hour fluence was initially above the Active threshold (1e8 integrated pfu), dropping below at the 23/1200 UTC observation. The 24/0000 UTC observation was 4.44e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a chance of isolated M-class flares.

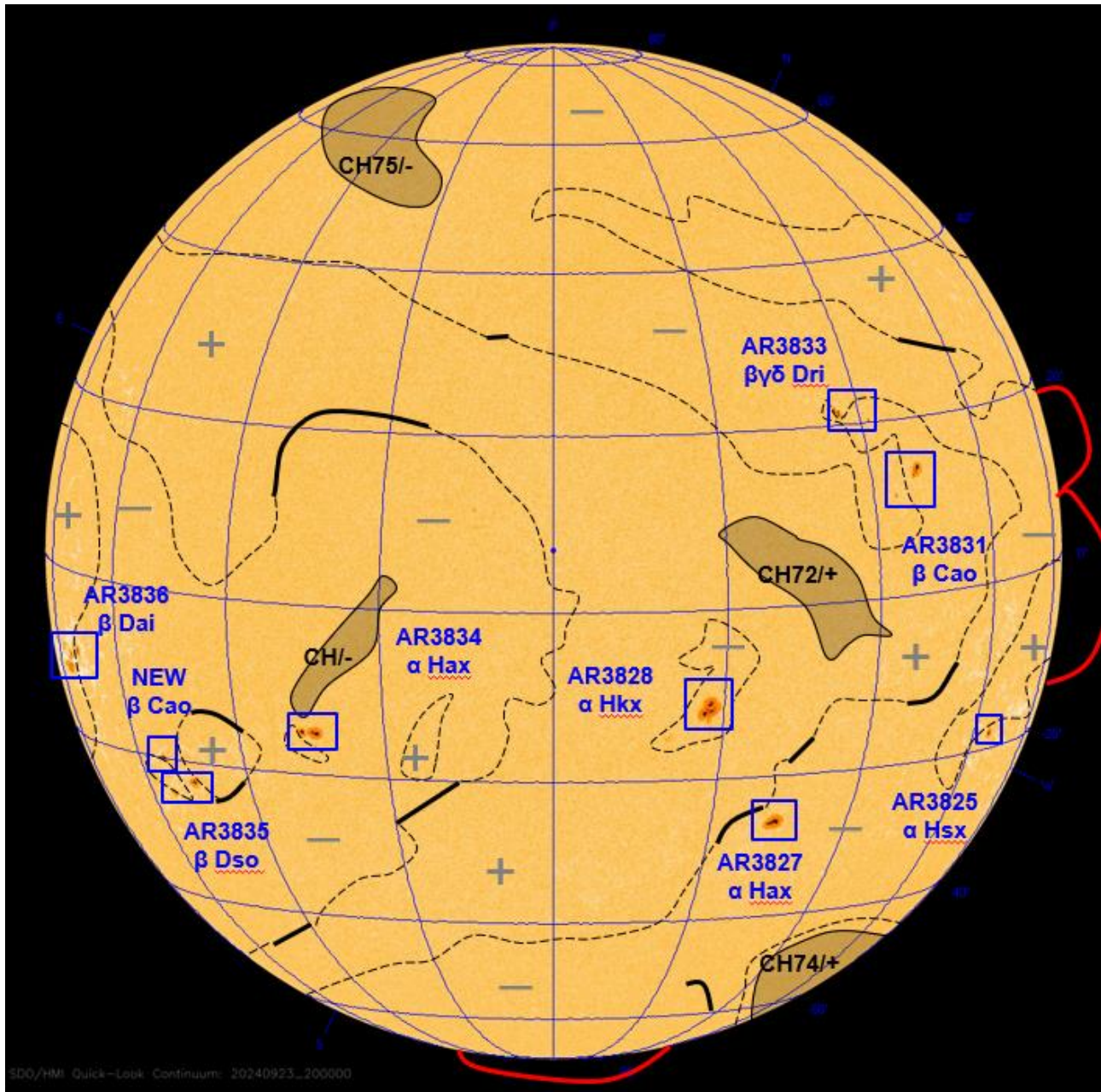
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

Solar Wind / Geomagnetic Activity: The partial halo CME following the M3.7 flare off the southeast quadrant on 22 Sep may give a glancing blow at Earth on Day 2 with effects potentially lasting into Day 3 (25-26 Sep). This may coincide with the arrival of any CIR or connection to the fast wind from CH72/+. However, this aspect of the forecast is considered to be low confidence. Solar wind speeds are currently slightly elevated under the influence of what appears to be a weak transient CME, and are likely to remain so with the arrival of any connection to the fast wind from CH72/+. If we also experience a glancing blow from the above mentioned CME then wind speeds could potentially become elevated.

Geomagnetic activity is forecast to be Quiet to Active at first, with a slight chance of G1/Minor Storm intervals under weak CME influence. If we see a combination of fast winds and CME influence on Days 2-3 then this will bring a likelihood of Active to G1/Minor Storm intervals. However, if we see more than just shock influence from the CME, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching G2-G3/Moderate-Strong Storm intervals. This is currently considered to be low confidence. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled during Day 4 (27 Sep).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is likely to remain at background levels. High energy electron flux at GOES16 has been moderate to high but appears to be declining, with a corresponding drop in fluence below the Active ($1e8$ integrated pfu) threshold. There is just a slight chance of fluence exceeding Active again in this period.

Figure 1. Solar Analysis Valid 23/2000 UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

The partial halo CME which was observed following the M3.7 flare off the southeast quadrant on 22 Sep has been analysed. Results suggest a possible glancing blow on Day 2 with effects potentially lasting into Day 3 (25-26 Sep). The bulk of the material appears to be heading below and behind Earth's orbit. However, coronagraph imagery suggests that some shock effects could reach Earth. This may coincide with the arrival of any CIR or connection to the fast wind from CH72/+. However, this aspect of the forecast is considered to be low confidence.

Solar wind speeds are currently slightly elevated under the influence of what appears to be a weak transient CME, and are likely to remain so with the arrival of any connection to the fast wind from CH72/+. If we also experience a glancing blow from the above mentioned CME then wind speeds could potentially become elevated. The coronal hole is a persistent feature and is in a generally similar location when compared to previous rotation, but is more defined and extends slightly further west on this occasion. However, on the previous rotation any impacts were largely swamped by ongoing CME effects. With the positive polarity of the coronal hole and the proximity of the September Equinox, this would suggest the possibility of some geomagnetic enhancement associated with this feature, although wind speeds did not go much above 400 km/s on the previous rotation and similar is likely this time. This largely fits with MOSWOC Enlil's forecast.

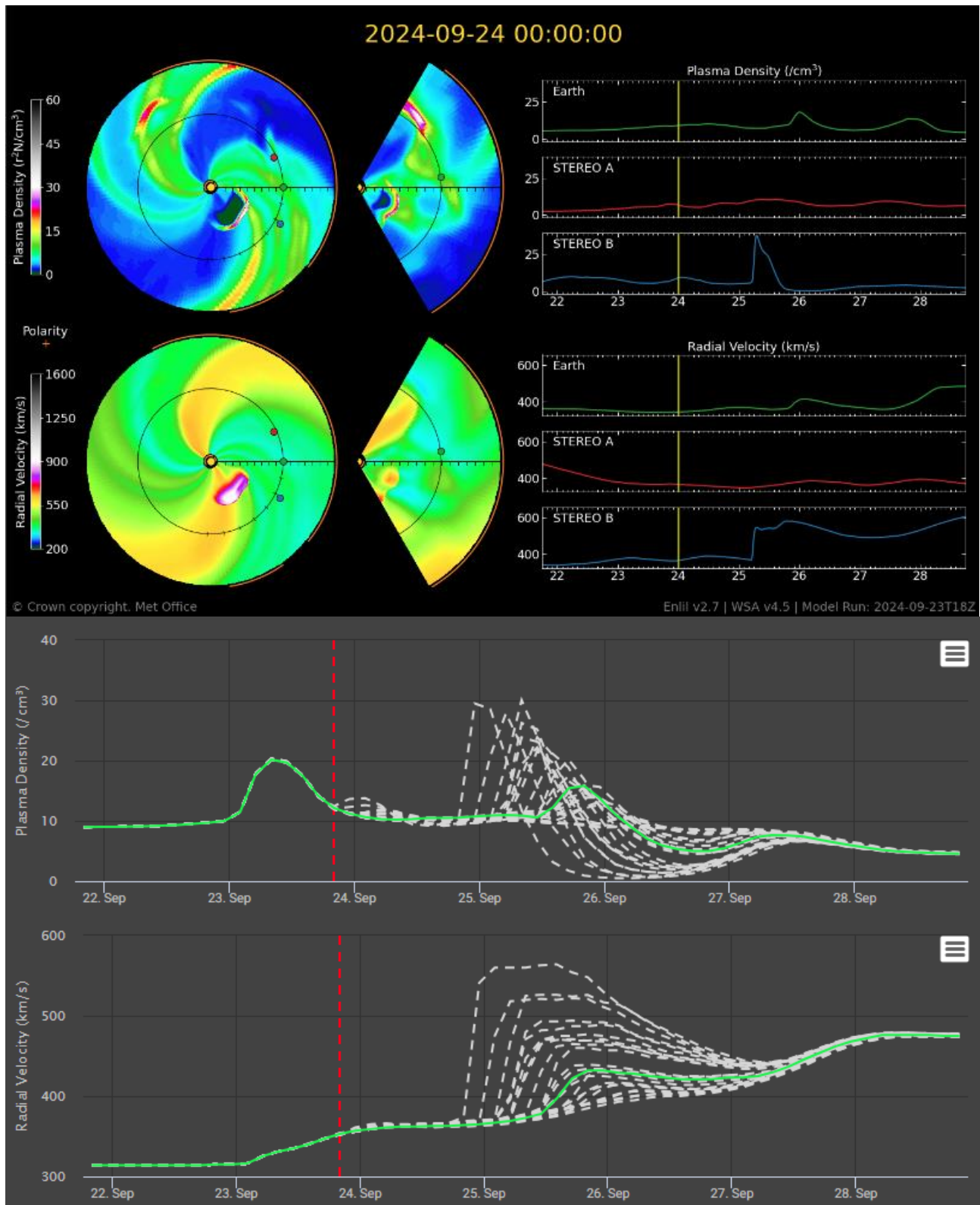
Geomagnetic activity is forecast to be Quiet to Active at first, with a slight chance of G1/Minor Storm intervals under weak CME influence. If we see a combination of CH72/+ fast winds and CME influence on Days 2-3 then this will bring a likelihood of Active to G1/Minor Storm intervals. However, if we see more than just shock influence from the CME, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching G2-G3/Moderate-Strong Storm intervals. This is currently considered to be low confidence. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled during Day 4 (27 Sep).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	60	20	5
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
23/0031	Partial	Filament	SE	1195 km/s	25/1200 UTC	Glancing blow likely

Figure 2: MOSWOC Enlil and ensemble, showing a likely CME glancing blow on 25 Sep.



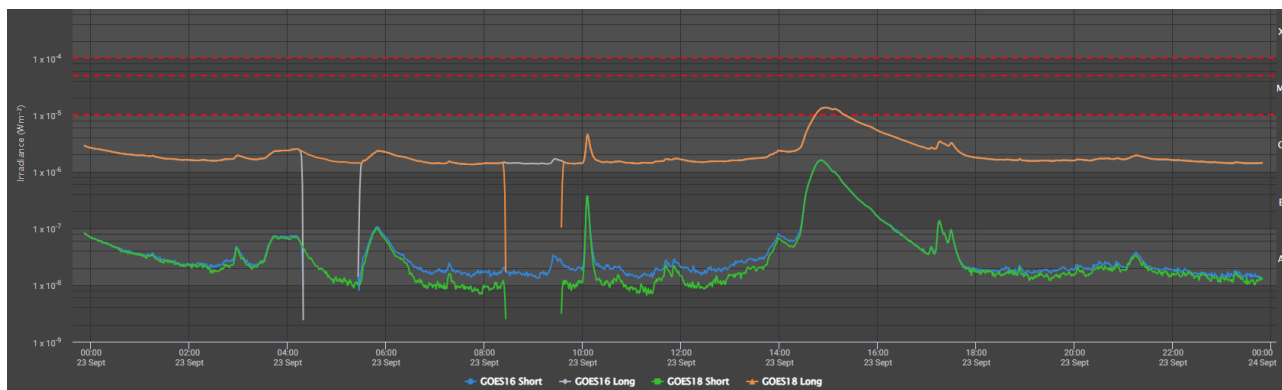
Radio Blackouts - X-Ray Flares:

Activity has been Moderate with a flare peaking at M1.3, at 23/1457 UTC from AR3836 with a contribution from AR3833. Activity is expected to remain Low to Moderate, with a chance of isolated M-class flares, most likely from AR3828, AR3833, or AR3836.

There are currently nine sunspot regions on the visible disc, with a new region developing north of AR3835. AR3833 in the northwest has been fading, but still just about contains a delta spot. AR3828 is also of note, but any opposite polarity spots have now faded. The new region on the southeast limb has been numbered AR3836 and remains very difficult to assess due to foreshortening near the limb, but is showing some notable looping in SDO imagery, so is one to watch. Remaining regions appear mostly small or simple at the present time.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: X-ray flux at GOES16 and 18, showing one M-flare in the last 24 hours.



Solar Radiation Storms - (High Energy Protons):

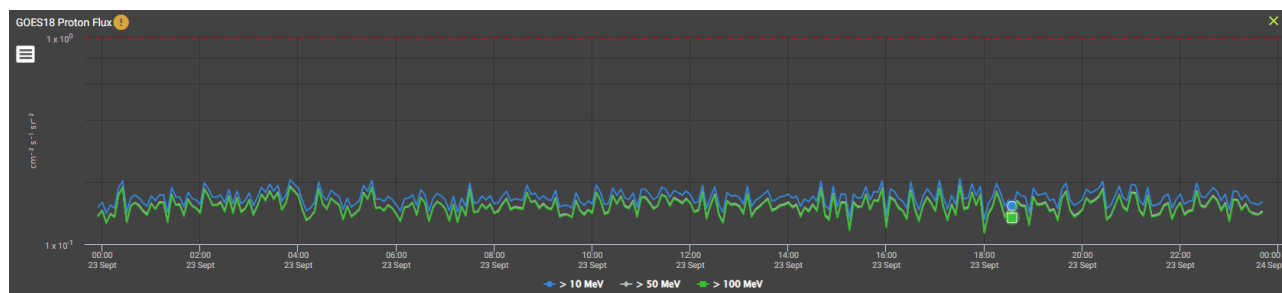
High energy proton flux at GOES18 is forecast to persist at background levels, with only a very slight chance of rising above the S1/Minor Radiation Storm threshold.

The majority of the sunspots on the disc are either small or simple. However the slight complexity apparent in AR3833 in the northwest results in a very slight chance of proton productive flares. There is also a non-zero, albeit very low chance of observable protons from any significant filament eruption, given the number and size of notable filaments currently on the disc.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: Proton flux at GOES18, which is at background levels.



High Energy Electrons Event ($\geq 2\text{MeV}$):

GOES-16 high energy electron flux has varied between moderate and high levels, likely as a consequence of an increase in flux after the CME arrival on 16-17 Sep, followed by an outward expansion of the radiation belts. Flux is likely to drop out under the current and forecast CME and HSS effects, with the subsequent increased solar wind pressure likely compressing the radiation belts once again. There is potential for another increase in flux later in the period, after CME and HSS effects have subsided.

The associated 24 hour fluence reached the Active ($1\text{e}8$ integrated pfu) level during 22-23 Sep but has since dropped below, likely due to the recent weak CME arrival. Confidence is low during this period, but it seems most likely that fluence will remain below the Active threshold on a declining trend at first, before potentially rising on Day 4 (27 Sep). MOSWOC REFM also suggests a gradual declining trend to the fluence, however until recently this has been consistently underestimating the observed fluence reducing confidence in this model guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	Yes	20	10	5	20
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM, showing a declining trend in fluence.

